OGP Progress Report

Analysis and Diagnostic Studies from SMN Radar and Related Data in Support of NAME

Project Duration: 12/1/2003-11/30/2006

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Introduction

This project focuses on providing quality control, processing, and analysis of SMN (Mexican weather service) radar data in support of NAME, the North American Monsoon Experiment. It is a collaborative effort between Colorado State University (CSU) and the National Center for Atmospheric Research (NCAR). Analysis of the SMN data will be directed at improving our understanding of convective processes within Tier I (the innermost domain) of NAME. The SMN radar data will address the GAPP science question, "Can we understand and predict the variations in the regional and global hydrological regime and water resources and its response and changes in the environment?" through providing improved understanding of convective processes during the North American Monsoon. This report covers most of the first year of this project, which mainly involved data collection.

Project Goals

- Assist in the collection of SMN radar data during the NAME extended observation period (EOP)
- Provide quality control to the data to remove spurious echo and calibrate reflectivity-based rainfall estimates
- Merge SMN radar data with S-Pol radar data and Name Event Raingage Network (NERN) data to create a composite rainfall, velocity, and reflectivity product at 15-minute intervals for the entire NAME EOP
- Perform basic statistical analyses on the merged product (e.g., convective storm morhphology, diurnal cycle of rainfall) to create secondary data products
- Provide the primary merged radar product and secondary statistical products to the NAME community
- Use the merged data to help validate regional models along with IR- and microwave-based satellite rainfall estimates.

Method

The acquisition of SMN radar data was led by NCAR. Four radars in Tier I (Guasave, Los Cabos, Obregon, and Palmito) were slated to be upgraded for the NAME EOP as part of a separate NOAA/PACS grant. The upgrade covered digitization and recording of data, as well as calibration and other radar maintenance. NCAR had equipment available to set up TITAN workstations on Internet connections at two radars, so that real-time radar imagery could be sent to the UCAR/JOSS NAME field catalog, in support of both

forecast and field operations. NCAR and CSU will collaborate in the quality control of the SMN radar data and the creation of a merged regional radar product. Our methodology for quality control and radar product generation will be covered in more detail in the "Future Work" section.

Results and Accomplishments

During this first year the main focus was on executing the upgrade of SMN radars and recording data during the NAME EOP, then bringing those data back to NCAR. This process was led by Jon Lutz, lead NCAR engineer on this project. Lutz was assisted by Arturo Valdez-Manzanilla. The SMN radar upgrades were successfully accomplished at the two most important radars – Guasave and Los Cabos. Guasave was upgraded and began recording onto removeable hard drives on 10 June 2004 and Los Cabos on 15 July. Both radars recorded well into the fall, with Guasave's hard disk probably filling up sometime in October. Los Cabos likely recorded well into September. The fall data still are in Mexico awaiting pickup, which will be scheduled soon (the exact time periods of fall recording will be known then). Currently we have raw Guasave data for 10 June through 15 September on the mass store at NCAR (some exceptions – see below). For Los Cabos we have 15 July through 21 August. Some points regarding these data:

- The pulse repetition frequencies (PRFs) of these radars were increased to 625 Hz at Guasave on 29 July and to 600 Hz at Los Cabos on 20 July. After these dates, Doppler data will be the most useful due to a higher Nyquist velocity (~7 m s-1).
- TITAN workstations on Internet connections were set up at both radars. These workstations regularly sent imagery files, including precipitation estimates, to the NAME field catalog at UCAR/JOSS throughout a large portion of the NAME EOP.
- Due to a slip ring assembly problem, the Los Cabos radar antenna was clamped at 0.6 deg elevation for the entirety of the recording period. Guasave was similarly restricted to ~1.5 deg elevation, but because running full volume scans interfered with operational radar imagery transmission to the SMN forecast office in Mexico City due to a software problem on the Mexican side. Therefore, we only have low-level sweep data from these two radars, and no vertical structure information for convection.
- The clamping of Los Cabos prevented solar gain calibrations. These calibrations were done regularly at Guasave, however. Both radars were able to have pointing angle calibrations done successfully. Guasave had some problems with poor dynamic range during much of July. This affected reflectivities and is correctable in post-processing. There were also some time errors (10 June-2 July) and a sign error in Doppler velocities at Guasave that can be corrected as well.
- A hard drive containing Guasave data for the 12-29 July period failed and has been sent to a data recovery service for repair. The service estimates the chances of full recovery of the data from the drive at greater than 90%.

The upgrades were not completed at Obregon and Palmito. While Obregon was being upgraded the transmitter failed due to a bad power supply. Though this problem was eventually fixed, by that time it was mid-August and SMN personnel were reluctant to allow further upgrade work to proceed. Palmito was struck by lightning in the spring. After this was fixed during the summer there were still severe logistical problems with

getting equipment and generator fuel shipped to the radar. Therefore, the upgrade was never attempted at Palmito.

Future Work

Processing of Guasave and Los Cabos data has begun at NCAR, under David Ahijevych (who is taking over the role of Jay Miller as defined in the original proposal). Timothy Lang (Colorado State University PI) and a CSU student will assist in this endeavor. The first steps will be converting the data files to DORADE format and applying reflectivity, time, and velocity corrections using the NCAR soloii software package. The reflectivity corrections will be determined using data from the calibrations performed at Guasave. Los Cabos data will be corrected using estimates of noise power. Where possible, we will use overlapping S-Pol and TRMM Precipitation Radar data to assist with reflectivity corrections.

We will use editing software to unfold velocities, remove clutter and other spurious echo, and where possible correct for any attenuation in heavy rain. Using S-Pol polarimetric radar data and NERN gauge-based rainfall estimates, we will develop a polarimetrically tuned Z-R relationship that can be applied to both radars, and create reflectivity and rainfall maps at 15-minute intervals. These maps will be merged with S-Pol data to create a composite regional grid of near-surface reflectivity and rainfall estimates for a large portion of Tier I. We plan on creating these composites for most of the NAME EOP when all three radars were operating (15 July through mid-to-late-August). We anticipate having a subset of these composites (probably for 1-15 August) available for presentation at the NAME workshop in March 2005. After soliciting feedback from the NAME community there, we will refine the composites and create the entire dataset.

One the final grids are complete we will commence performing basic statistics on the dataset, including analysis of the diurnal cycle and horizontal structure of convection. We will also provide the final grids to the NAME community, and when we are complete, the basic statistical analyses as well. We will use the final grids to help validate regional models as well as valdiate satellite rainfall retrievals.

Publications from this project

None currently

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Workplan For Coming Year

November 2004 through March 2005
Perform quality comtrol on a maximum two-week subset of the SMN radar data as described in the "Future Work" section. This work will be performed by David Ahijevych of NCAR, Timothy Lang of CSU, and a CSU student (Gustavo Pereira). Also during this time, David Ahijevych will develop a protoype composite regional grid based on the one described in the original proposal. This grid will be modified from the one originally described in that it will be two-dimensional, due to the lack of vertical data from the SMN radars. There will be three fields – near-surface reflectivity, near-surface velocity, and near-surface rainfall. CSU personnel will use S-Pol radar data to develop a polarimetrically tuned Z-R relationship that can be applied to the SMN radar reflectivies to provide highly accurate rainfall estimates for this region. We will collaborate with David Gochis of NCAR in merging gauge measurements from the NERN into the rainfall field to help improve the rainfall estimates as well. The composite grids for this maximum two-week period will be presented at the NAME Workshop in March 2005, probably in the context of a case study over a hydrologically gauged watershed.

March-November 2005
Using feedback from the NAME Workshop, refine as needed the composite product design to suit NAME community requirements. Then, utilizing lessons learned from the preliminary quality control and gridding process, create the merged radar product for the entire NAME EOP at 15-minute intervals. Create subset composites for other periods when only 1-2 radars were available (June, early July, fall), also at 15-minute intervals. Began statistical analyses on the final gridded composite dataset.